CRITICAL MANAGEMENT PRACTICES IN REDUCING CONSTRUCTION PROJECT ON-SITE WASTE

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PERPUSTAKAAN TUNKU TUN AMINAH

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I dedicate this study to my beloved family and friends, who were always with me through ups and downs along this great journey to complete this study. A special loving couple I dedicate too, which is my parents, En. Mohd Zain bin Che Long and Pn. Fatimah bt Ahmad, always support and giving encouragement for successful this thesis with excellent.

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ABSTRACT

Rapid development in construction industry has led to the increasing of the construction waste in Malaysia. Improper construction waste management practice had caused adverse impacts towards environment, social and economy. This study seeks to identify the critical management practices in reducing construction project on-site waste through the evaluation construction industry practitioner's perception, based on the understanding that effective construction waste management will lead to on-site waste reduction. A quantitative research method by using questionnaire approach is adopted in order to obtain perceptions regarding critical construction waste management practices from construction industry players. As much as 52 practices that contribute for successful on-site construction waste minimization were found from literature review. Statistically, 135 respondents who are working as client, consultant and contractor organization participated in this study. The response rate for the actual questionnaire survey is 67%. After the validity test of the constructs and the reliability test of the questionnaire, data analysis was carried out through a combination of Kruskal-Wallis analysis and Descriptive Mean Ranks analysis by using SPSS version 22. The findings from this study show that the most prominent factor of on-site waste management is the 'Regulation' and then followed by management of 'Construction Method', 'Administrative, 'Human Resources' and 'Material and Equipment' respectively. About 20 critical construction waste management practices were determined. The most critical practice in reducing on-site construction waste is the implementation of Site Waste Management Plan in construction project. This study will guide the construction players to apply specific measures to reduce on-site construction waste generation. The findings will indirectly assist project managers to achieve targeted performance in construction projects and also will directly reduce the impact of construction waste towards environment.

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ABSTRAK

Pembangunan yang pesat dalam industri pembinaan telah menyebabkan berlakunya peningkatan sisa bahan binaan di Malaysia. Amalan pengurusan sisa pembinaan yang tidak betul telah mengakibatkan kesan buruk terhadap alam sekitar, sosial dan ekonomi. Kajian ini bertujuan untuk mengenal pasti amalan pengurusan yang kritikal bagi mengurangkan sisa di tapak projek pembinaan melalui penilaian pandangan ahli industri pembinaan, berdasarkan pemahaman pengurusan sisa pembinaan yang berkesan akan membawa kepada pengurangan sisa di tapak. Kaedah penyelidikan kuantitatif dengan menggunakan pendekatan soal selidik telah digunakan bagi mendapatkan persepsi dari ahli industri pembinaan mengenai amalan pengurusan sisa pembinaan yang kritikal. Sebanyak 52 amalan yang mempengaruhi keberkesanan amalan pengurusan sisa pembinaan di tapak telah ditemui dari hasil kajian literatur. Secara statistik, 135 responden yang bekerja di dalam organisasi klien, perunding dan kontraktor telah menyertai kajian ini. Kadar maklum balas bagi kaji selidik yang sebenar ialah 67%. Selepas ujian kesahihan konstruk dan ujian kebolehpercayaan borang soal selidik dilakukan, analisis data dijalankan melalui gabungan analisis 'Kruskal-Wallis' dan analisis 'Descriptive Mean Ranks' dengan menggunakan perisian SPSS versi 22. Hasil kajian menunjukkan bahawa faktor paling penting dalam pengurusan sisa di tapak ialah 'Peraturan' dan kemudian diikuti oleh pengurusan 'Kaedah Pembinaan', 'Pentadbiran', 'Sumber Manusia' dan 'Bahan dan Peralatan'. Sebanyak 20 amalan pengurusan sisa pembinaan kritikal telah ditentukan. Amalan yang paling kritikal dalam mengurangkan sisa pembinaan di tapak ialah pelaksanaan 'Rancangan Pengurusan Sisa Tapak' dalam projek pembinaan. Kajian ini akan membantu ahli industri pembinaan untuk melaksanakan langkah-langkah tepat dalam mengurangkan penjanaan sisa pembinaan di tapak bina. Hasil dapatan kajian ini secara tidak langsung akan membantu pengurus projek dalam mencapai sasaran prestasi dalam projek pembinaan dan secara langsung akan membantu dalam mengurangkan kesan buruk sisa bahan binaan terhadap alam sekitar.

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LIST OF SYMBOLS AND ABBREVIATIONS

α	-	Alpha value
ANOVA	-	Analysis of Variance
C	-	Margin of error
CaCO3	-	Calcium Carbonate
C&D	-	Construction and demolition
CIDB	-	Construction Industry Development Board
CIMP	-	Construction Industry Master Plan
CITP	-	Construction Industry Transformation Programme
CWM	-	Construction Waste Management
df	-	Degree of freedom
GDP	-	Gross Domestic Product
GFCF	-	Gross Fixed Capital Formation
GNI	-	Gross National Income
GWP	-	Global Warming Potential
k	-	The number of item considered
K-S	-	Kolmogorov-Smirnov
IBS	-	Industrialised Building System
MHLG	-	Ministry of Housing and Local Government
Phd	-	Doctor of Philosophy
P	-	Percentage picking a choice
r	-	The mean of the inter-item correlation

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PCBs	-	Polychlorinated Biphenyls
Sig.	-	Significant
SPSS	-	Statistical Package for the Social Sciences
S.S	-	Sample Size
S-W	-	Shapiro-Wilk
x^2	-	Chi-square
US	-	United States
Z	-	Confidence Level

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The construction sector plays a vital role in every developing country. Nowadays, the industry faces many challenges relating to construction waste. In the last two decades, there have been increasing construction wastes caused by inefficient waste management practices in the construction projects (Saadi et al., 2016). This phenomenon also caused by the increase in the standard of living, changes in consumption habits and also caused by the population increase (Nagapan et al., 2012b). The United States of America Environmental Protection Agency has reported that the construction industry contributes about 40% of the entire wastes (US EPA, 2014). In Peninsular Malaysia, the amount of solid waste generated per day increased from an estimated 23,000 tonnes in 2010 to 25,000 tonnes in 2012 (Abu Eusuf et al., 2012). Currently, Solid Waste and Public Cleansing Management Corporation of Malaysia confirms that approximately 8 million tonnes of construction wastes per year are generated from construction projects (Taha, 2015). Besides being a waste contributor, this generation of wastes has a negative impact on the environment, cost, productivity, time, social, and economy to the industry (Marzouk & Azab, 2014). It is expected that this issue will become worse if the management of responsible practitioners towards construction waste problem is not emphasized.

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Proper construction waste management is very important to ensure the sustainability concept can be achieved. The process of managing construction waste goes far beyond the disposal of the wastes itself. It is encompassing a strategy to effectively utilize construction resources in the most effective way, with the aim to reduce the volume of construction waste production as much as possible throughout all the construction phases (Esa, Halog, & Rigamonti, 2017). In line with that, a proper waste management practice can be attained through a good site management. Nowadays, a good approach through the site management has been increasingly well-known its effectiveness for achieving the targeted performances (including waste management) in a construction project. This is due to the base understanding that a good site management is an important factor to achieve project performance indicators such as time, cost, quality, waste and safety targets (Ajayi et al., 2017). Through an intensive study in construction site management, it has been proved that a good site management will influence a proper waste management at a construction site and at once will be able to minimize construction waste generation (Udawatta et al., 2015; Marinelli et al., 2014).

There is an urgent need to look for improvements in the present construction waste management practices in order to reduce waste effectively, conserve landfills capacity, achieving the concept of sustainability in waste construction (Subramaniam et al., 2018). Hence, the strategy to reduce the construction waste generated by industry through the good management practices has become one of the top issues to be discussed nowadays. As a result, different construction management practices have been recognized as been essential in reducing construction waste to landfill. In connection with the topic, this study is conducted to identify and determine the critical management practices which are influencing on-site waste minimization for construction projects in Malaysia.

1.2 Problem Statement

The urbanization, population rapid growth, industrialization and economic development in Malaysia have produced mass solid waste. It is found that the construction industry is identified as one of the largest contributors towards mass production of solid waste in Malaysia (Marzouk & Azab, 2014). According to Wahi

et al. (2016), the world cities are producing as much as 1.3 billion tonnes of solid waste for every year. This volume of waste is predicted to rise up to 2.2 billion tonnes by the end of 2025. Across the globe, the construction industry generates about 44% of landfill waste in the United Kingdom, 29% in the United State, 44% in Australia (Ajayi et al., 2017) and 40% in China (Ding et al., 2016). In Malaysia, Solid Waste and Public Cleansing Management Corporation of Malaysia (SWCorp) confirms that approximately 8 million tonnes of construction wastes per year (21,918 tonnes per day) were generated from construction projects (Taha, 2015). In addition, currently, Malaysia generates 26,000 tonnes of wastes daily from construction works that further congest the already over-flowing landfills (Esa et al., 2017). Based on the stated statistic of waste production around the world, it is confirmed that there is an increase in construction waste products within the construction industry. Hence, it is important to determine waste management practices that able to minimize the construction waste generation. In facts, the increasing of construction waste in Malaysia will bring negative impact on the environment, social and economic. As the result, the issue of minimizing construction waste becoming a great concern to the developing countries such as Malaysia.

Along with the significant increase of construction waste production from the construction industry, the extent problem from rapid development in Malaysia had caused construction waste illegal dumping phenomenon (Esa et al., 2016). Nowadays, illegal dumping from construction waste had found to be one of the pressing issues in Malaysia. The previous studies had shown the increasing cases of illegal dumping activities across Peninsular Malaysia from 2004 to 2015 (Rahim et al., 2017; Yahaya & Larsen, 2008; Rahmat & Ibrahim, 2007; Asaari et al., 2004). As for example, about 851 of illegal dumping area has been identified by SWCorp Malaysia. Evidently, Karim (2018) had reported illegal dumping site mainly contained construction debris had found at the end of the road of Tiara Titiwangsa 3, Taman Titiwangsa as shown in Figure 1.1. Meanwhile, on October 27, 2014, News Strait Times had highlighted the illegal dumping issue of construction waste in an open spaced near Kampung Aman 1 flats Sri Kembangan as shown in Figure 1.2 (Muhamading, 2014). In addition, on 24 January 2017, The Star Newspaper had reported the occurrence of construction waste on a slip road at Jalan Lagong in Klang (Michael, 2017). This illegal dumping issue will cause risk to human health and the environment (Rahmat & Ibrahim, 2007). According to Nagapan at al., (2012a), the issue of illegal dumping arise due to the cost

and project location factors. The distance between the project location and the landfill site hinder the contractor to dispose of construction waste in the legal landfill. This issue has become a great concern to the local authority and it will give many negative effects towards the environment, social and economy.

Figure 1.1: Construction waste are illegally dumped at the end of the road (Karim, 2018).

Figure 1.2: Illegal dumping of construction waste in an open space near Kampung Aman 1 flats in Seri Kembangan (Muhamading, 2014).

Apart from that, the uncontrollable generation of construction waste will cause the landfills rapidly reached its maximum capacity. According to Sin et al. (2013), the landfill is the ultimate waste disposal method that can deal with many types of materials. In Malaysia, the common practice in disposing of construction waste is by

directly disposing them to the proper dumpsite such as landfill (Saadi et al., 2016). This method is chosen among contractor in Malaysia because the waste materials are assumed to have a little premium value. In addition, the contractors perceived this method as the best solution to deal with the generation of construction waste. This situation has led the contractors to dispose the construction waste directly to the landfill. However, this conventional practice will no longer be applicable for a long term since there is an increasing amount of construction waste year by year which will make the landfills reach its full capacity. Table 1.1 shows the percentage increase of waste disposed of through landfill until the targeted year 2020. Since the construction industry has generated the amount of waste, it also takes up large space of the landfills. Evidently, it was reported that among 289 landfills including dumpsites, 113 of these landfills are no longer in operation due to protest from surrounding residents or have reached their full capacity (Nagapan et al., 2012a). Landfills are regarded as one of major negative impact on the environment in Malaysia due to the poor management of landfills from the responsible party. Hence, an improvement of construction waste management strategy should be periodically done since the issues of limited landfills faces by some of the developed countries becomes crucial.

Table 1.1: Method of waste disposal in Malaysia (Sin et al., 2013)

Treatment	Percentage of Waste Disposed		
	2002	2006	Target 2020
Recycling	5.0	5.5	22.0
Composting	0.0	1.0	8.0
Incineration	0.0	0.0	16.8
Inert landfill	0.0	3.2	9.1
Sanitary landfill	5.0	30.9	44.1
Other disposal Site	90.0	59.4	0.0
Total	100.0	100.0	100.0

Meanwhile, the Construction Industry Development Board (CIDB) of Malaysia has been dynamically encouraging the practice of industrialized building system (IBS) in local construction industries since 1998 as a technique to overcome construction waste problem, conserve landfill capacity and also helping to achieve the concept of sustainability in Malaysia (Azman et al., 2013). Unfortunately, because of the higher initial cost that incurs during the construction process, there is a significant percentage of construction projects do not adopt the use of IBS technology and other off-site construction techniques (Saadi et al., 2016), thus making it less critical practice

to reduce the construction waste in the current construction mainstream. In addition, according to Tam et al. (2006), the hindrances in applying prefabrication such as inflexible for design changes, lack of research information, higher initial construction cost, limited site space and lack of expertise are the causes of less IBS implementation among contractors in construction projects. Corroborates with the statement, Yuan (2013b) claimed that some management practices such as the "implementation of IBS technology" and "increasing the fee for waste disposal in landfill" are not considered as critical by construction practitioners, although these two management practices have been broadly recognized as effective in minimizing construction waste.

Generally, the previous research on the construction waste management in Malaysia is mainly discussed on the implementation of government policies, strategies, legislation and law enforcement on waste management such as in the study of Saadi et al., (2016), Wahi et al., (2016) and Nagapan et al, (2012a). However, the government policies are still not effectively taken by the industry practitioners. The policies are not enough to encompass whole concept of sustainability (Sin et al., 2013). The policies only emphasized to the level of implementation 3R hierarchy concept towards construction waste management as the measures to reduce construction waste. Moreover, there are less information and data are provided on the critical practices that should be carried out to reduce construction waste generation in Malaysia. A study by Papargyropoulou et al, (2011) only emphasized on the implementation of Site Waste Management Plans (SWMP) in Malaysia as the practice to reduce construction waste and it specifically focused on the contractor perspectives only. In addition, a study regarding construction waste management practices in Malaysia by Esa et al., (2017) are not emphasizing the contradiction perception issues that arise within the different group of construction industry players. In line with that, the evaluation of the construction industry practitioner's perception towards construction waste management practices should be incorporate to determine the effectives waste management practices at construction site.

Hence, based on the highlighted issues, an effective solution should be proposed to solve construction waste problems. The effective construction waste management practices that lead towards a better on-site waste minimization is one of the best approaches in order to achieve the sustainability goal and targeted performance in a construction project. This study will determine and highlight the

critical management practices that influence on-site waste minimization in construction projects.

1.3 Research Questions

Based on the problem statement, this study has come up with the following research questions:

i. What are the waste management practices that able to engender waste minimization?
ii. What is the perception of the construction industry practitioners in the client, consultant and contractor organization regarding waste minimization practices?
iii. What are the critical management practices to reduce construction waste generation in construction projects?

1.4 Research Objectives

The aim of this study is to determine the critical management practices influencing on-site waste minimization in construction projects. Minimizing construction waste is defined herein as the practice which contributes to reducing construction waste generation through the construction process. The hypothesis is that effective construction waste management will be able to engender on-site waste reduction. This research will highlight the critical practices that can be adapted to minimize on-site construction waste through the identification of critical management practices that leads to a better management in waste minimization. The objectives of this study are as follow:

i. To identify the current on-site waste minimization practices for construction waste management in construction projects.
ii. To evaluate the differences in perception among the client, consultant, and contractor regarding key site management practices for construction waste minimization.
iii. To determine the critical management practices in minimizing on-site construction waste production for construction projects.

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1.5 Scopes of Study

The scope of this study is mainly focused on the current management practices in construction project. Kruskal-Wallis analysis was used to analyze non-parametric data regarding the perception of construction industry practitioners towards 52 waste minimization practices. Following that, Descriptive Means analysis was applied to determine the critical management practices in reducing on-site construction waste. Furthermore, the practices regarding on the construction waste management were identified first through a literature review on the 20 research articles and then these parameters were inserted in a structured questionnaire survey in order to determine the top management practices. The questionnaire survey was conducted by posting mail, emailing, in-person meeting and using web services such as Google survey. Since the number of respondent population was difficult to determine because there was no database that provides directly this information and hindrance of time and cost, the sample size for this study was determine through an equation that adopted from the previous study in the construction field.

The limitations of this study are on-site waste management.

i. The information and data collection only covers the construction projects within Peninsular Malaysia which are Selangor, Johor, Pahang, and Kelantan. The state of Selangor and Johor are chosen because there is rapid development of construction project in this region. Meanwhile, Kelantan and Pahang are selected because it eases the researcher to access for data collection due to cost and time constraint factors.
ii. This study only used a quantitative research method using a structured questionnaire survey.
iii. The minimum sample size for this study is 118 respondents with the 95% confidence level of the data collection.
iv. The criteria of the respondents should be the person who directly involved with construction process. The respondents are randomly selected during the actual questionnaire survey.
v. The data collection limit to the only organization (unit of analysis) of the construction industry practitioners.

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vi. The data collection was limited to the on-site construction waste management practices at residentials, non-residentials, infrastructures and social amenities only.

1.6 Thesis Structure

This study focused on the construction waste management practices that able to mitigate on-site construction waste production. This study is divided into five chapters as stated in the next paragraph.

This first chapter discusses the need of the study. It contains background, problem statement to summarize the main research questions, objectives and scopes of the study.

The second chapter consists of the review of published research works for the related study on construction waste management practices. Further, it highlights the practices regarding on-site construction waste management practices.

The third chapter explains the research plan and the methodology implemented for this research work. It presents details of analyzing approaches used for data analysis together with the data collection technique.

The fourth chapter presents the evaluation, analysis, and discussion in detail. The data obtained through the actual questionnaire survey were analyzed and interpreted.

Lastly, the fifth chapter concludes the whole research conducted in order to meet the objectives.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In recent years, the number of construction project has increased rapidly due to the 11th Malaysian plan (Nagapan et al., 2013). Unfortunately, the construction industry caused a lot of harmful and negative impact on the surrounding environment in order to fulfill the demands of the present developments (Noor et al., 2013). In line with that, there have been increasing construction wastes causing from insufficient waste management practices in the construction projects. Waste management in the construction industry in Malaysia has become a major environmental issue in the past recent years. This issue has become one of the Malaysia greatest concern when a large amount of construction wastes is being dumped directly to the landfill. Hence, the understanding of construction waste problem is essential in order to overcome this problem effectively.

This chapter provides a literature review on the construction waste, construction waste causes, and generation, classification of construction waste, the impact of construction waste and construction waste minimization concept. This chapter aims to give a deep understanding and knowledge regarding construction waste and its subjected issues. It discusses how construction waste has become a concerned issue in the Malaysian construction project and the importance of efficient

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